Institute for Water Resources
US Army Corps of Engineers

New Decision Support Tools to Assist in Corps Ecosystem Restoration Projects

L. Leigh Skaggs, IWR

Planning Community of Practice Conference

May 2008

Topics

- ***IWR Planning Suite improvements***
  - Assists plan formulation
  - Performs Cost Effectiveness/ Incremental Cost Analyses (CE/ICA)
  - Annualizes ecosystem outputs & costs
  - Can assist in multi-criteria decision analysis (MCDA)

IWR Planning Suite Background

- Evolutionary outgrowth of previous efforts to automate CE/ICA
- Tables & graphs as record of analyses
- Allows more complicated analyses
- Predecessors:
  - EcoEasy: MS-DOS based, USACE Evaluation of Environmental Investments Research Program, 1995
  - IWR-Plan Versions 1 to 3.33, MS-Access VBA-based application with C++ kernel, 1999-2002
- Current development environment: MS Visual Studio 2005, written in C-sharp

IWR-PLAN

DECISION SUPPORT S

VERSION 3.33

IWR Plan - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address http://www.pmcl.com/iwrplan/default.htm

US Army Corps of Engineers

IWR PLAN

COST EFFECTIVENESS INCREMENTAL COST ANALYSIS

General Info. | Classic IWR-PLAN | New Software | News Board | Dev. Team | Site Map

WELCOME...

to the IWR-PLAN Decision Support Software Site. The US Army Corps of Engineers Institute for Water Resources provides this site to supply news and information related to IWR-PLAN and to provide access to the IWR-PLAN download site.

Developed in partnership with the Social Sciences Institute of the Natural Resources Conservation Service, IWR-PLAN was initially designed to assist with the formulation and comparison of alternative plans for ecosystem restoration and watershed planning studies. However, the program can be applied to planning studies addressing a wide variety of problems.

Briefly, IWR-PLAN assists with plan formulation by combining user-defined solutions to planning problems and calculating the effects of each combination, or "plan." The program can assist with plan comparison by conducting cost effectiveness and incremental cost analyses, identifying the plans which are best financial investments and displaying the effects of each on a range of decision variables. For a more detailed explanation of IWR-PLAN's capabilities, click on the General Info button of the navigation chart above.

Download and installation instructions are provided by clicking on the Software Info button of the navigation bar above. IWR-PLAN program files require about 13 megabytes of hard disk storage space and often take about 20 to 30 minutes to download, depending on Internet traffic volumes and modem speeds. Click on the Software Info button above for more detailed information on hardware and software system requirements.

IWR-PLAN is free to the public. We encourage its use and welcome user feedback. Future software enhancements and capabilities are scheduled. As these modifications are completed and tested, they will be incorporated into new versions of the software and made available from the download site. New versions will be announced on the News Board. Check the News Board regularly for information about future IWR-PLAN updates.

For more information about the US Army Corps of Engineers: USACE Home or our Institute for Water Resources: IWR Home

Latest News concerning IWR-PLAN decision support software

- New Version Available!
- Version 3.3 Available!
- Workaround for MS Office 2000 users

Home | General Info. | Software Info. | New Software Info. | News Board | Dev. Team

http://www.pmcl.com/iwrplan/default.htm

start | Inbox - Microsoft ... | IWR Planning Suite... | IWRPlanSuite_for_... | IWR Planning Suite... | IWR Plan - Micros...

IWR Planning Suite Planning Study "BusseyLakeNov06" - [CEICA Synergy Exercise #6 (CE/ICA)]

File Edit View Window Analyze Results Decision Making Generator Help

CEICA Synergy Exercise #6 (CE/ICA)

Name	Totalcost	FishHU's	BirdHU's	Fauna	FishHU's High	Totalcost Low	Cost Effective
No Action Plan	0	0	0	0	0	0	Best Buy
D1H0A0S0K0I0	101.6	24	5	19.25	28.8	91.44	No
D2H0A0S0K0I0	122.7	28	7	22.75	33.6	110.43	No
D3H0A0S0K0I0	176.2	33	9	27	39.6	158.58	No
D4H0A0S0K0I0	192	41	12	33.75	49.2	172.8	No
D5H0A0S0K0I0	196.1	42	15	35.25	50.4	176.49	No
D6H0A0S0K0I0	205.2	44	18	37.5	52.8	184.68	No
D7H0A0S0K0I0	227.2	48	25	42.25	57.6	204.48	No
D0H1A0S0K0I0	23.4						No
D0H2A0S0K0I0	26						No
D0H3A0S0K0I0	28.6						No
D0H4A0S0K0I0	30						No
D0H5A0S0K0I0	30.8						No
D1H1A0S0K0I0	125						No
D2H1A0S0K0I0	146.1						No
D3H1A0S0K0I0	199.6						No
D4H1A0S0K0I0	215.4						No
D5H1A0S0K0I0	219.5						No
D6H1A0S0K0I0	228.6						No
D7H1A0S0K0I0	250.6						No
D1H2A0S0K0I0	127.6						No
D2H2A0S0K0I0	148.7						No
D3H2A0S0K0I0	202.2						No
D4H2A0S0K0I0	218						No
D5H2A0S0K0I0	222.1						No
D6H2A0S0K0I0	231.2						No
D7H2A0S0K0I0	253.2	53	25	46	63.6	227.88	No
D1H3A0S0K0I0	130.2	35	5	27.5	42	117.18	No
D2H3A0S0K0I0	151.3	39	7	31	46.8	136.17	No
D3H3A0S0K0I0	204.8	44	9	35.25	52.8	184.32	No
D4H3A0S0K0I0	220.6	52	12	42	62.4	198.54	No
D5H3A0S0K0I0	224.7	53	15	43.5	63.6	202.23	No
D6H3A0S0K0I0	233.8	55	18	45.75	66	210.42	No
D7H3A0S0K0I0	255.8	59	25	50.5	70.8	230.22	No
D1H4A0S0K0I0	131.6	38	5	29.75	45.6	118.44	No
D2H4A0S0K0I0	152.7	42	7	33.25	50.4	137.43	No
D3H4A0S0K0I0	206.2	47	9	37.5	56.4	185.58	No
D4H4A0S0K0I0	222	55	12	44.25	66	199.8	No

446 Plans | About IWR Planning Suite... | 12/4/2006

About IWR Planning Suite

US Army Corps of Engineers

IWR PLANNING SUITE

IWR Planning Suite 1.0.3.0 - 03 Nov 2006

Total Physical Memory: 536,272,896 bytes
Processor: Intel(R) Pentium(R) III Mobile CPU 1000MHz
1 Processor detected
Screen Mode: 1,280 by 1,024

Monday, December 04, 2006

HQ-FOA\skaggs

Close

start | U.S. Army Enginee... | Inbox - Microsoft ... | Microsoft PowerPoi... | 2 Windows Explorer | Adobe Reader | 9:54 AM

IWR-Planning Suite

- **Available on web**
- **Website: *www.pmcl.com/iwrplan***
  - **Instructions**
  - **Student tutorial**
  - **User's Guide**
- **For on-line help, click on "?"**

Visit IWR's Homepage
www.iwr.usace.army.mil

U.S. Army Engineer Institute for Water Resources - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address http://www.iwr.usace.army.mil/index.cfm

HOME | NEWSROOM | WHO WE ARE | WHERE WE ARE | MISSION | CONTACT US | SEARCH | SITE MAP | CORPS HOME | KIDS CORNER

US Army Corps of Engineers®
institute for water resources

RELEVANT
READY
RESPONSIVE
RELIABLE

Proudly serving the Armed Forces and the Nation now and in the future.

Search | Projects | Library | Training | Partners | Forum | IWR @ Work

inside the institute
- News & Events
- People & Places
- Products & Services

corps water resources
- Programs
- Planning & Management
- Results

water resources outlook
- Challenges
- Activities
- Forum

Quick Clicks
- Projects
- Library
- Training
- Partners
- Forum
- IWR @ Work

USA.gov
The U.S. Government's official web portal

The Institute Leads the Corps in Water Resources

Top News Story

IWR Team in Turkey for 5th World Water Forum and World Water Day 2008
More on this story...

News from Inside the Institute

Partnering Agreement with Japan extended 5 years
A U.S. delegation including two representatives from the Hydrologic Engineering Center (HEC) traveled to Tokyo, Japan as part of a Water Resources Technical Exchange meeting between USACE and the Japanese Ministry of Land, Infrastructure, Transportation and Tourism (MLIT) from 26-28 February 2008. A key part of the visit was the signing of a 5-year extension of the USACE-MLIT partnering agreement, which was scheduled to expire in March 2008.
More on this story...
More from Inside the Institute ...

News from Corps Water Resources

IWR Participates at United Nations High Level Expert Panel on Water and Disasters in Seoul, Korea
IWR was part of a U.S. Army Corps of Engineers team that participated in the second meeting of the United Nations High Level Expert Panel on Water and Disasters in Seoul, Korea on 28-29 January 2008. Mr. Stockton, Deputy Director of Civil Works, presented material about the Corps Civil Military Emergency Preparedness program. Dr. Delli Priscoli, a senior advisor on international water issues at IWR and a key planner for the upcoming 5th World Water Forum, facilitated a session tasked with developing potential actions for the Panel to consider that will address issues of water-related disasters.
More on this story...
More from Corps Water Resources ...

IWR Centers

Hydrologic Engineering Center
Navigation Data Center
Waterborne Commerce Statistics Center

Satellite Sites

Value to the Nation
U.S. Section PIANC
Inland Waterways Users Board
RWS/USACE Water Partnership

Advanced Degree Program
Civil Military Emergency Preparedness Program
Navigation Economic Technologies Program
National Flood Risk Management Program
National Shoreline Management Study
Shared Vision Planning

4th International Symposium on Flood Defence

Welcome

Local intranet

start | 2 Internet... | Inbox - Micr... | Microsoft W... | Adobe Reader | IWR Plannin... | 2 Microsof... | Skaggs | 4:07 PM

Visit the *IWR-PLAN* Homepage

www.pmcl/com/iwrplan

IWR Plan - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites

Address http://www.pmcl.com/iwrplan/ Go Links

US Army Corps of Engineers ®

IWR PLAN

COST EFFECTIVENESS
INCREMENTAL COST ANALYSIS

General Info. | Classic IWR-PLAN | New Version | News Board | Dev. Team | Site Map

WELCOME...

to the IWR-PLAN Decision Support Software Site. The US Army Corps of Engineers Institute for Water Resources provides this site to supply news and information related to IWR-PLAN and to provide access to the IWR-PLAN download site.

Developed in partnership with the Social Sciences Institute of the Natural Resources Conservation Service, IWR-PLAN was initially designed to assist with the formulation and comparison of alternative plans for ecosystem restoration and watershed planning studies. However, the program can be applied to planning studies addressing a wide variety of problems.

Briefly, IWR-PLAN assists with plan formulation by combining user-defined solutions to planning problems and calculating the effects of each combination, or "plan." The program can assist with plan comparison by conducting cost effectiveness and incremental cost analyses, identifying the plans which are best financial investments and displaying the effects of each on a range of decision variables. For a more detailed explanation of IWR-PLAN's capabilities, click on the General Info button of the navigation chart above.

Download and installation instructions are provided by clicking on the Software Info button of the navigation bar above. IWR-PLAN program files require about 13 megabytes of hard disk storage space and often take about 20 to 30 minutes to download, depending on Internet traffic volumes and modem speeds. Click on the Software Info button above for more detailed information on hardware and software system requirements.

IWR-PLAN is free to the public. We encourage its use and welcome user feedback. Future software enhancements and capabilities are scheduled. As these modifications are completed and tested, they will be incorporated into new versions of the software and made available from the download site. New versions will be announced on the News Board. Check the News Board regularly for information about future IWR-PLAN updates.

For more information about the US Army Corps of Engineers: USACE Home or our Institute for Water Resources: IWR Home

Latest News concerning IWR-PLAN decision support software

- New Version Available!
- Version 3.3 Available!
- Workaround for MS Office 2000 users

Home | General Info. | Software Info. | New Software Info. | News Board | Dev. Team

Internet

IWR Planning Suite Basics

- **Assists in plan formulation**
  - **Builds “all plan combinations”**
  - **52 solutions, 20 scales each**
  - **Also, fully formulated alternatives**
  - **Dependency & combinability relationships**
- **No limit on number of variables, including:**
  - **Costs**
  - **1 or more outputs**
  - **Other “effects”**
  - **“Derived” outputs (formulaic combinations of other variables)**
- **Performs CE/ICA**
  - **CEA: Cost effective plans**
  - **ICA: Best buy plans**

Features

Analytical

- Multiple planning sets
- Constraints
- Sensitivity – variable & solution
- Automated Editing – non-additive effects
- Exclude solutions
- Multi-planning set comparisons
- "Plans of Interest"

Reporting

- Multiple display/ report options
- Import/ Export options

Features

Comprised of modules:

- **Plan Editor**
  - **also “framework” for other modules**
- **Plan Generator**
  - **builds combinations**
- **Plan Analysis**
  - **performs CE/ICA**
- **Annualizer**
  - **beta testing**
- **Multi-criteria Decision Analysis**
  - **beta testing**

Plan Editor Overview

Planning Set Properties

Enter Constraints

Plan Study

Delete Planning Set

Variable Sensitivity

Plan Study Planning Sets: Select Planning Set to perform actions upon.

The Default Planning Set: Lets you type in Plan Alternatives directly.

Turn modules on and off

IWR Planning Suite

Editor Module

IWR Planning Suite Planning Study "MCDAExampleMay2008" - [Planning Set 1 (Editor)]

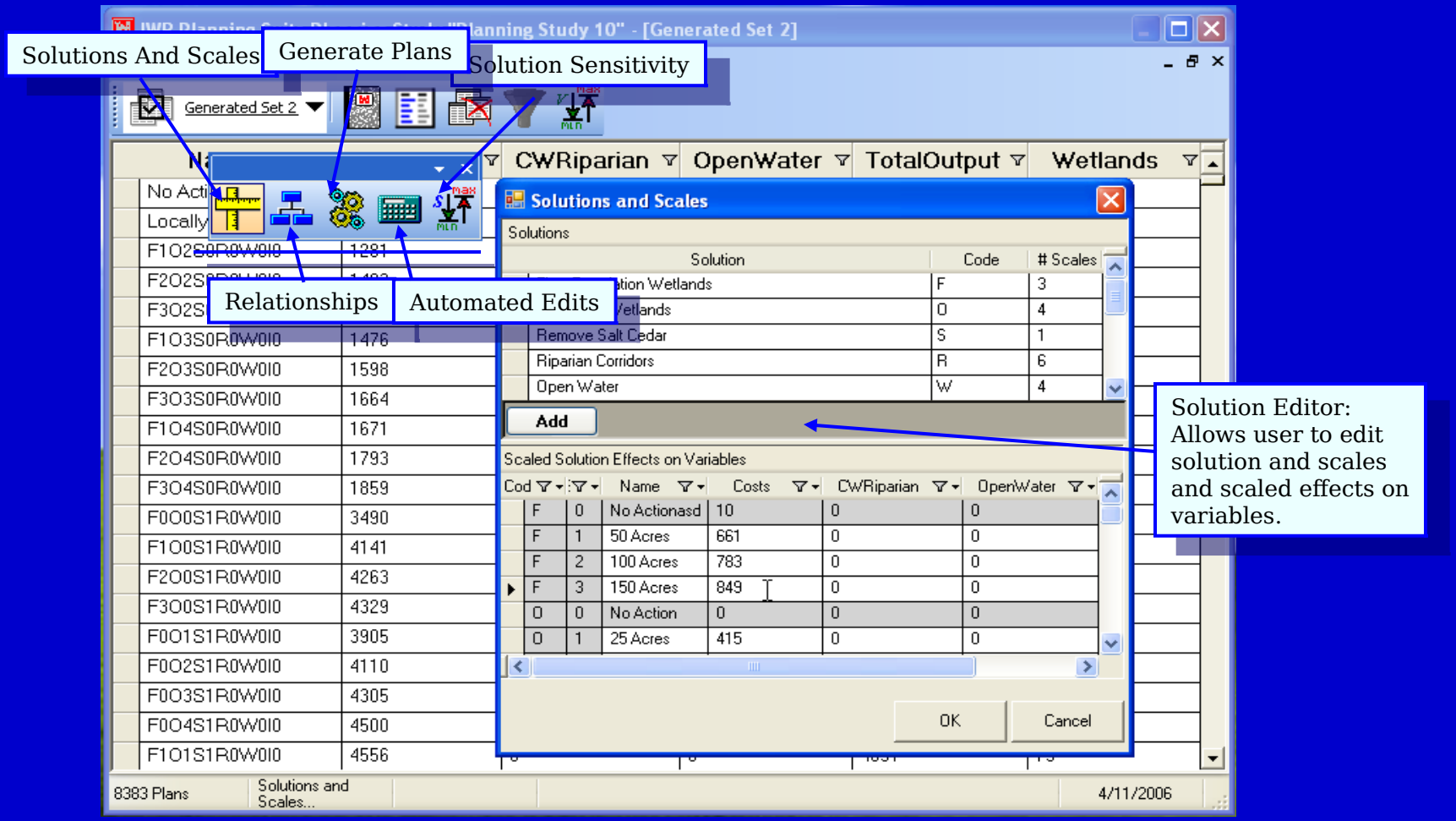
File Edit View Window Analyze Results Decision Making Generator Help

Planning Set 1 (Editor)

Name	Cost	Env Output	Water Quality	Flood Risk Mgt	RED Impacts	Rank	Score
No Action Plan	0	0	0	0	0		
Habitat Plan	2686	1200	28	300	150		
WQ Plan	4298	500	60	100	200		
Flood Mgt Plan	4029	50	10	4100	800		
RED Plan	4835	300	15	4100	1300		
Grand Plan	5372	1000	40	3500	1200		

6 Plans 5/1/2008

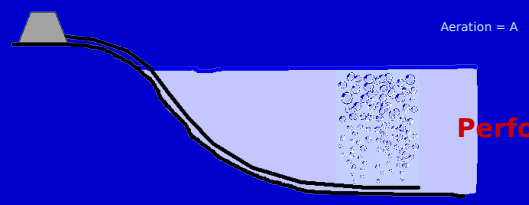
Plan Generator Module



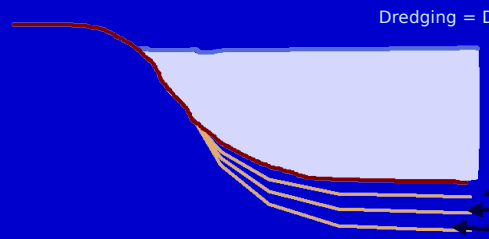
IWR Planning Suite

Plan Alternative Example

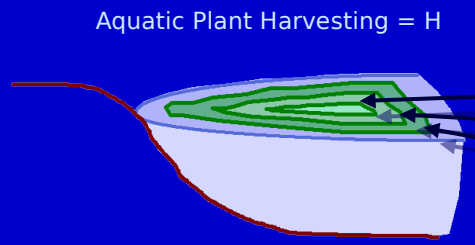
"Perform aeration, dredge 185,000 cubic yards of sediment, do no aquatic plant harvesting, and improve the substrate."



Perform Aeration = A1



(Cubic Yards)
140,000 = D1
185,000 = D2
220,000 = D3



No Action = H0
21 Acres = H1
42 Acres = H2
63 Acres = H3

Improve Substrate = S1

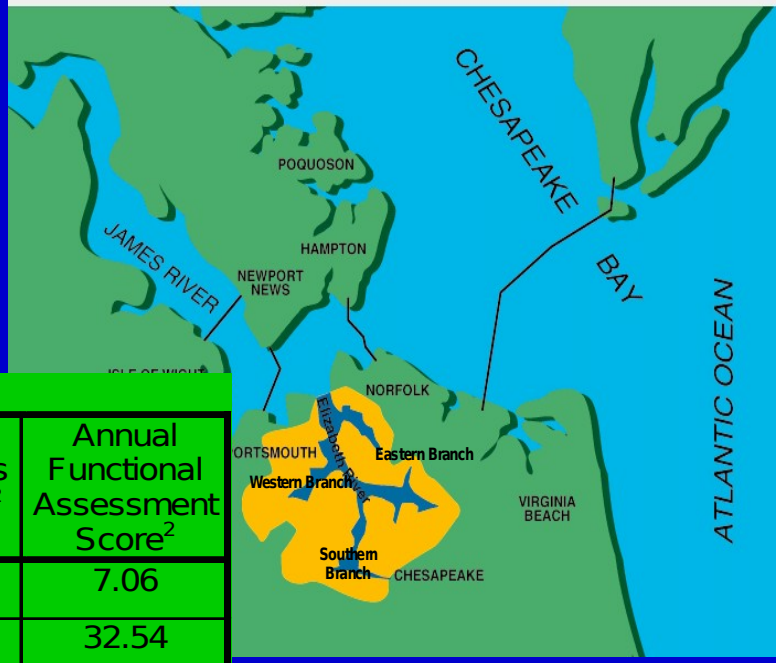
Plan alternative broken down:

Perform Aeration is A1
Dredge 185,000 Cubic Yards is D2
Do not harvest (No Action) is H0
Improve Substrate is S1

A1	D2	H0	S1

No Aeration = A0
No Dredging = D0
No Harvesting = H0
No Substrate = S0

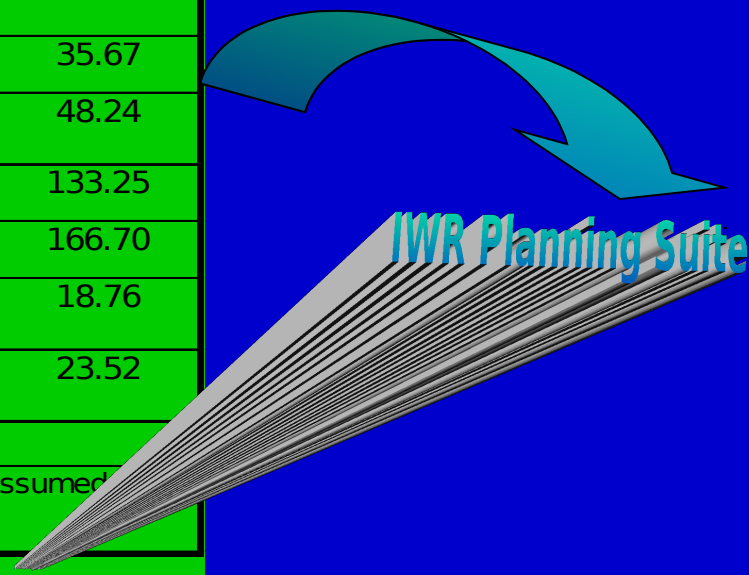
Elizabeth River Wetlands Case Study



Location	Total Implementation Costs	Average Annual Costs[1]	Annual Habitat Units (from HEP)[2]	Annual Functional Assessment Score[2]
Sugar Hill, Portsmouth	$136,876	$9,600	0.25	7.06
Carolanne Farms, VA Beach	$297,431	$20,700	1.05	32.54
Somme Avenue, Norfolk	$308,610	$21,400	0.54	14.75
Scuffletown, Chesapeake	$87,781	$6,200	0.28	6.92
NW Jordan Bridge, Portsmouth	$237,564	$16,500	1.14	31.61
Crawford Bay, Portsmouth	$355,413	$24,700	1.18	35.67
Woodstock Park, VA Beach	$499,738	$34,600	1.52	48.24
Lancelot Drive, VA Beach	$1,583,079	$109,400	4.49	133.25
Grandy Village, Norfolk	$1,124,410	$77,800	3.99	166.70
ODU Drainage Canal, Norfolk	$175,795	$12,300	0.56	18.76
Portsmouth City Park, Portsmouth	$333,369	$23,200	0.67	23.52

[1] Average annual equivalent costs derived using an interest rate of 6-5/8%.

[2] Full realization of benefits is anticipated in year 3. Linear interpolation of benefits is assumed between years one and three.



Enter Cost & Environmental Output Data (Wetlands)

IWR Planning Suite Planning Study "Elizabeth Wetlands" - [Planning Set 1 (Editor)]

File Edit View Window Analyze Results Decision Making Generator Help

Planning Set 1 (Editor)

Name	Cost	Habitat	FunctionalScore
No Action Plan	0	0	0

Solutions and Scales

Solutions

Solution	Code	# Scales
Sugar Hill	A	1
Carolanne Farms	B	1
Somme Ave	C	1
Scuffletown	D	1
NW Jordan Bridge	E	1
Crawford Bay	F	1
Woodstock Park	G	1
Lancelot Drive	H	1
Grandy Village	I	1
ODU Drainage Canal	J	1
Portsmouth City Park	K	1

Add

Scaled Solution Effects on Variables

Cod		Name	Cost	FunctionalScore	Habitat
A	0	No Action	0	0	0
A	1	Sugar Hill	9.6	7.06	0.25
B	0	No Action	0	0	0
B	1	Carolanne F	20.7	32.54	1.05
C	0	No Action	0	0	0
C	1	Somme Ave	21.4	14.75	0.54
D	0	No Action	0	0	0
D	1	Scuffletown	6.2	6.92	0.28
E	0	No Action	0	0	0
E	1	NW Jordan B	16.5	31.61	1.14
F	0	No Action	0	0	0
F	1	Crawford Ba	24.7	35.67	1.18
G	0	No Action	0	0	0
G	1	Woodstock P	34.6	48.24	1.52
H	0	No Action	0	0	0
H	1	Lancelot Driv	109.4	133.25	4.49
I	0	No Action	0	0	0
I	1	Grandy Villa	77.8	166.7	3.99
J	0	No Action	0	0	0
J	1	ODU Draina	12.3	18.76	0.56
K	0	No Action	0	0	0

OK Cancel

1 Plan 12/4/2006

start IWR Plan - Micros... Inbox - Microsoft ... 2 Microsoft Offic... Adobe Reader IWR Planning Suit... 11:10 AM

(2,048)

IWR Planning Suite Planning Study "Eliz Wet May 2008" - [Generated Set 2 (Generated)]

File Edit View Window Analyze Results Decision Making Generator Help

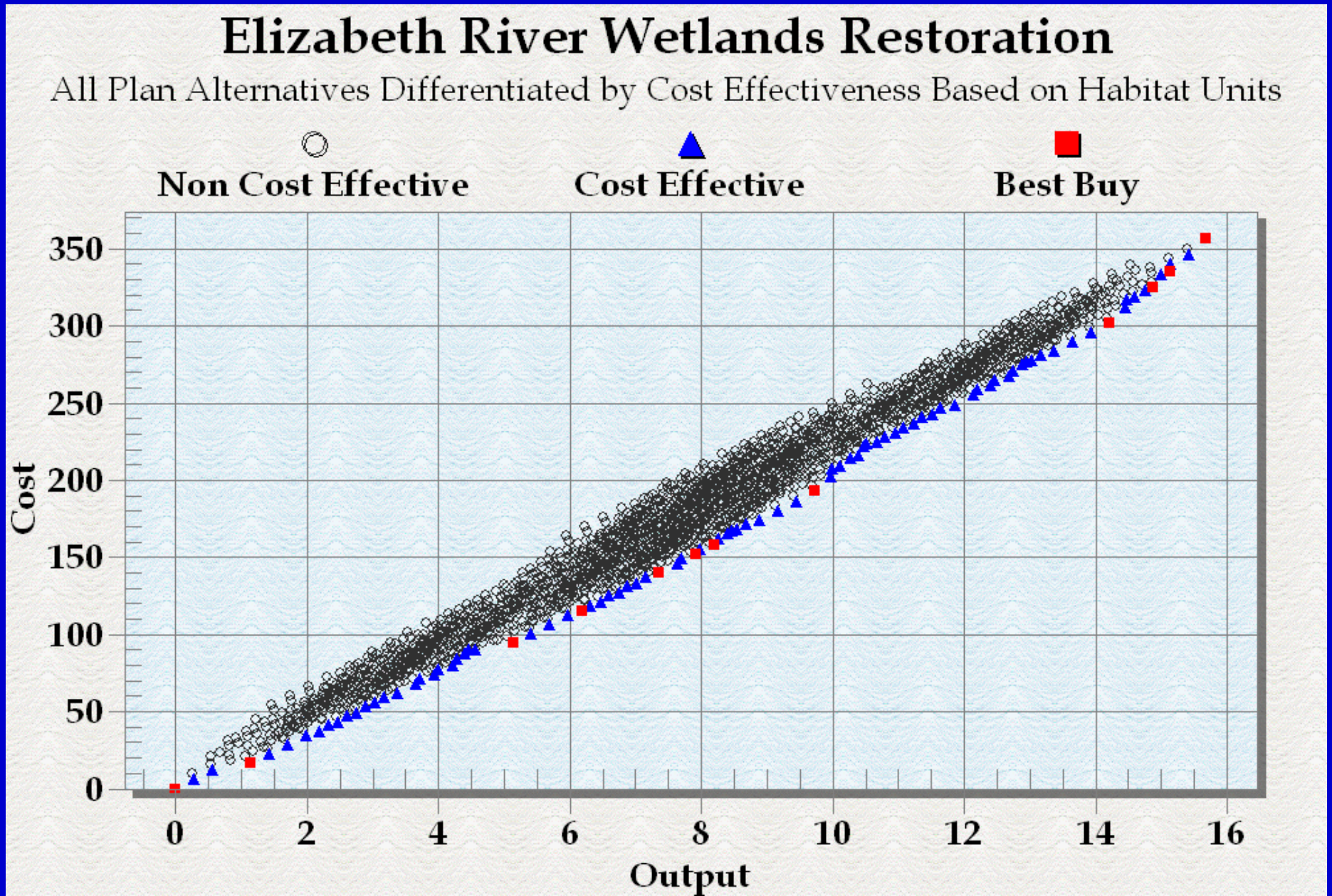
Generated Set 2 (Generated)

Name	Cost	Habitat	Functional Scor
No Action Plan	0	0	0
A1B0C0D0E0F0G0H0I0J0K0	9.6	0.25	7.06
A0B1C0D0E0F0G0H0I0J0K0	20.7	1.05	32.54
A1B1C0D0E0F0G0H0I0J0K0	30.3	1.3	39.6
A0B0C1D0E0F0G0H0I0J0K0	21.4	0.54	14.75
A1B0C1D0E0F0G0H0I0J0K0	31	0.79	21.81
A0B1C1D0E0F0G0H0I0J0K0	42.1	1.59	47.29
A1B1C1D0E0F0G0H0I0J0K0	51.7	1.84	54.35
A0B0C0D1E0F0G0H0I0J0K0	6.2	0.28	6.92
A1B0C0D1E0F0G0H0I0J0K0	15.8	0.53	13.98
A0B1C0D1E0F0G0H0I0J0K0	26.9	1.33	39.46
A1B1C0D1E0F0G0H0I0J0K0	36.5	1.58	46.52
A0B0C1D1E0F0G0H0I0J0K0	27.6	0.82	21.67
A1B0C1D1E0F0G0H0I0J0K0	37.2	1.07	28.73
A0B1C1D1E0F0G0H0I0J0K0	48.3	1.87	54.21
A1B1C1D1E0F0G0H0I0J0K0	57.9	2.12	61.27
A0B0C0D0E1F0G0H0I0J0K0	16.5	1.14	31.61
A1B0C0D0E1F0G0H0I0J0K0	26.1	1.39	38.67
A0B1C0D0E1F0G0H0I0J0K0	37.2	2.19	64.15
A1B1C0D0E1F0G0H0I0J0K0	46.8	2.44	71.21
A0B0C1D0E1F0G0H0I0J0K0	37.9	1.68	46.36
A1B0C1D0E1F0G0H0I0J0K0	47.5	1.93	53.42
A0B1C1D0E1F0G0H0I0J0K0	58.6	2.73	78.9
A1B1C1D0E1F0G0H0I0J0K0	68.2	2.98	85.96
A0B0C0D1E1F0G0H0I0J0K0	22.7	1.42	38.53
A1B0C0D1E1F0G0H0I0J0K0	32.3	1.67	45.59
A0B1C0D1E1F0G0H0I0J0K0	43.4	2.47	71.07
A1B1C0D1E1F0G0H0I0J0K0	53	2.72	78.13
A0B0C1D1E1F0G0H0I0J0K0	44.1	1.96	53.28
A1B0C1D1E1F0G0H0I0J0K0	53.7	2.21	60.34
A0B1C1D1E1F0G0H0I0J0K0	64.8	3.01	85.82
A1B1C1D1E1F0G0H0I0J0K0	74.4	3.26	92.88
A0B0C0D0E0F1G0H0I0J0K0	24.7	1.18	35.67
A1B0C0D0E0F1G0H0I0J0K0	34.3	1.43	42.73
A0B1C0D0E0F1G0H0I0J0K0	45.4	2.23	68.21
A1B1C0D0E0F1G0H0I0J0K0	55	2.48	75.27
A0B0C1D0E0F1G0H0I0J0K0	46.1	1.72	50.42
A1B0C1D0E0F1G0H0I0J0K0	55.7	1.97	57.48

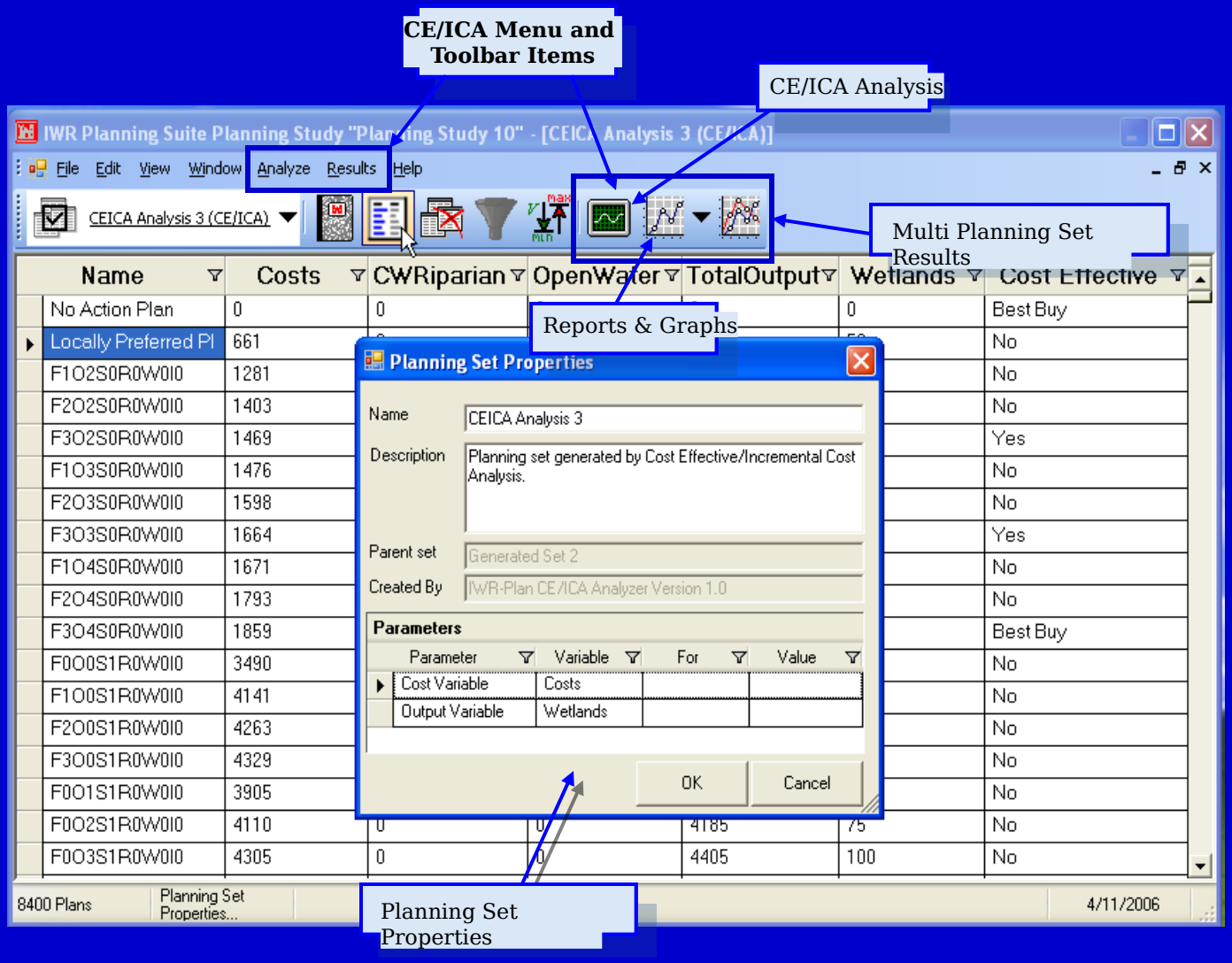
2048 Plans 5/1/2008

start Sent Items - Microsof... IWRPlanSuite_for_PC... Microsoft Excel - Eliza... IWR Planning Suite Pl... 12:36 PM

(2,048)


Elizabeth River Wetlands Restoration
All Plan Alternatives Differentiated by Cost Effectiveness Based on Habitat Units
Non Cost Effective
Cost Effective
Best Buy
Cost
350
300
250
200
150
100
50
0
0
2
4
6
8
10
12
14
16
Output

Analysis Module



IWR Planning Suite

Perform CE/ICA: Wetlands Restoration - HEP

IWR Planning Suite Planning Study "Elizabeth Wetlands" - [Generated Set All Combos (Generated)]

File Edit View Window Analyze Results Decision Making Generator Help

Generated Set All Combos (Generated)

Name	Cost	Habitat	FunctionalScore
No Action Plan	0	0	0
A1B0C0D0E0F0G0H0I0J0K0	9.6	0.25	7.06
A0B1C0D0E0F0G0H0I0J0K0	20.7	1.05	32.54
A1B1C0D0E0F0G0H0I0J0K0	30.3	1.3	39.6
A0B0C1D0E0F0G0H0I0J0K0	21.4	0.54	14.75
A1B0C1D0E0F0G0H0I0J0K0	31	0.79	21.81
A0B1C1D0E0F0G0H0I0J0K0	42.1	1.59	47.29
A1B1C1D0E0F0G0H0I0J0K0	51.7	1.84	54.35
A0B0C0D1E0F0G0H0I0J0K0	6.2	0.28	6.92
A1B0C0D1E0F0G0H0I0J0K0	15.8	0.53	13.98
A0B1C0D1E0F0G0H0I0J0K0	26.9		39.46
A1B1C0D1E0F0G0H0I0J0K0	36.5		46.52
A0B0C1D1E0F0G0H0I0J0K0	27.6		21.67
A1B0C1D1E0F0G0H0I0J0K0	37.2		28.73
A0B1C1D1E0F0G0H0I0J0K0	48.3		54.21
A1B1C1D1E0F0G0H0I0J0K0	57.9		61.27
A0B0C0D0E1F0G0H0I0J0K0	16.5		31.61
A1B0C0D0E1F0G0H0I0J0K0	26.1		38.67
A0B1C0D0E1F0G0H0I0J0K0	37.2		64.15
A1B1C0D0E1F0G0H0I0J0K0	46.8		71.21
A0B0C1D0E1F0G0H0I0J0K0	37.9		46.36
A1B0C1D0E1F0G0H0I0J0K0	47.5		53.42
A0B1C1D0E1F0G0H0I0J0K0	58.6		78.9
A1B1C1D0E1F0G0H0I0J0K0	68.2		85.96
A0B0C0D1E1F0G0H0I0J0K0	22.7	1.42	38.53
A1B0C0D1E1F0G0H0I0J0K0	32.3	1.67	45.59
A0B1C0D1E1F0G0H0I0J0K0	43.4	2.47	71.07
A1B1C0D1E1F0G0H0I0J0K0	53	2.72	78.13
A0B0C1D1E1F0G0H0I0J0K0	44.1	1.96	53.28
A1B0C1D1E1F0G0H0I0J0K0	53.7	2.21	60.34
A0B1C1D1E1F0G0H0I0J0K0	64.8	3.01	85.82
A1B1C1D1E1F0G0H0I0J0K0	74.4	3.26	92.88
A0B0C0D0E0F1G0H0I0J0K0	24.7	1.18	35.67
A1B0C0D0E0F1G0H0I0J0K0	34.3	1.43	42.73
A0B1C0D0E0F1G0H0I0J0K0	45.4	2.23	68.21
A1B1C0D0E0F1G0H0I0J0K0	55	2.48	75.27
A0B0C1D0E0F1G0H0I0J0K0	46.1	1.72	50.42
A1B0C1D0E0F1G0H0I0J0K0	55.7	1.97	57.48

Perform CE/ICA Analysis

Name: CEICA Based on Habitat

Description: Cost Effective/Incremental Cost Analysis Based on Habitat Units

Parent set: Generated Set All Combos

Created By: IWR-Plan CE/ICA Analyzer Version 1.0

CE/ICA Analysis Variables

Cost: Cost Output: Habitat

OK Cancel

Saving Current Planning Set CE/ICA 12/4/2006

start IWR Plan - Micros... Inbox - Microsoft ... 2 Microsoft Offic... Adobe Reader IWR Planning Suit... 11:14 AM

Perform CE/ICA: Wetlands Restoration - HEP

IWR Planning Suite Planning Study "Eliz Wet May 2008" - [CEICA Analysis 4 (CE/ICA)]

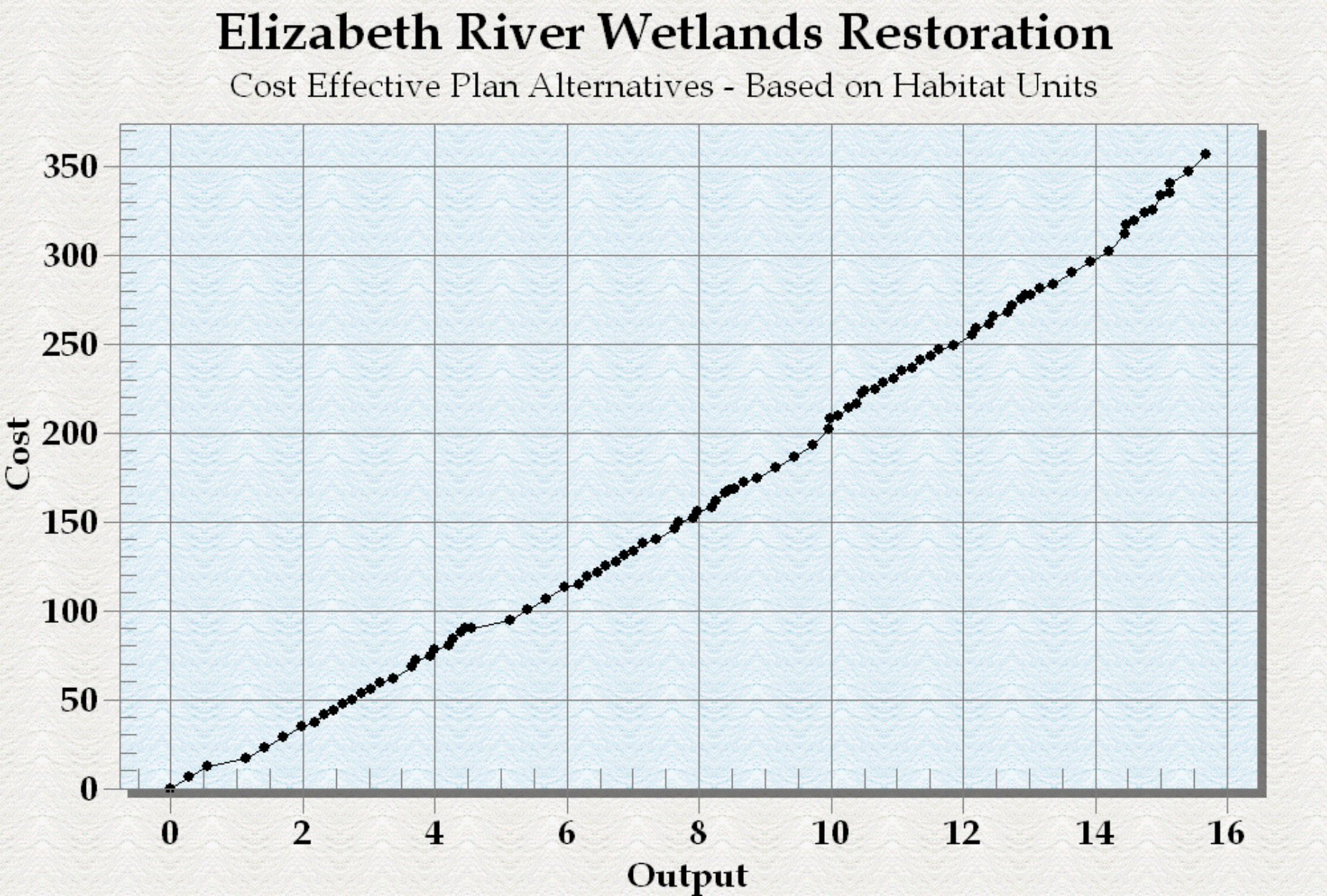
File Edit View Window Analyze Results Decision Making Generator Help

CEICA Analysis 4 (CE/ICA)

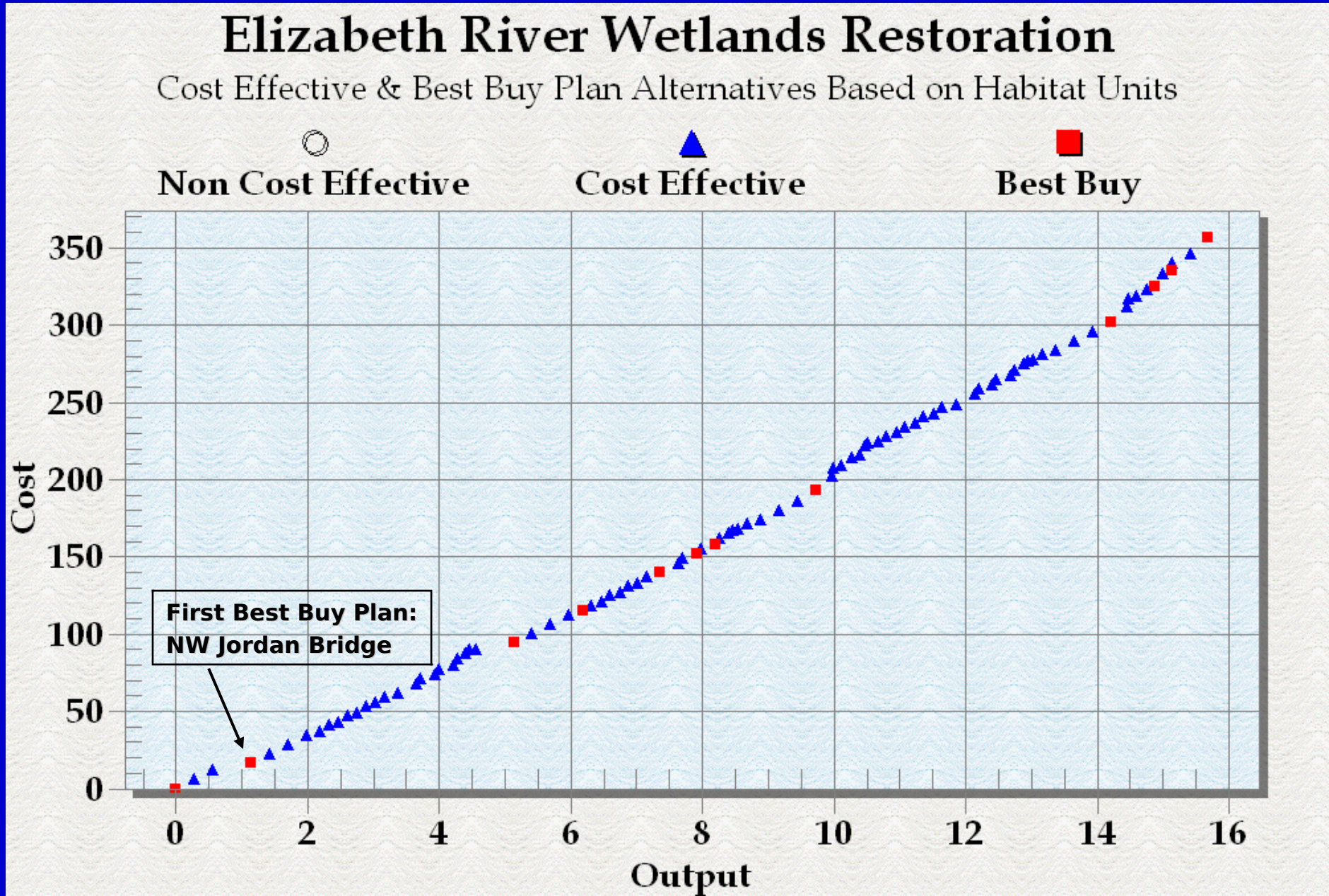
Name	Cost	Habitat	Functional Scor	Cost Effective
A0B1C0D0E1F1G0H1I1J0K0	249.1	11.85	399.77	Yes
A1B1C0D0E1F1G0H1I1J0K0	258.7	12.1	406.83	No
A0B0C1D0E1F1G0H1I1J0K0	249.8	11.34	381.98	No
A1B0C1D0E1F1G0H1I1J0K0	259.4	11.59	389.04	No
A0B1C1D0E1F1G0H1I1J0K0	270.5	12.39	414.52	No
A1B1C1D0E1F1G0H1I1J0K0	280.1	12.64	421.58	No
A0B0C0D1E1F1G0H1I1J0K0	234.6	11.08	374.15	Yes
A1B0C0D1E1F1G0H1I1J0K0	244.2	11.33	381.21	No
A0B1C0D1E1F1G0H1I1J0K0	255.3	12.13	406.69	Yes
A1B1C0D1E1F1G0H1I1J0K0	264.9	12.38	413.75	No
A0B0C1D1E1F1G0H1I1J0K0	256	11.62	388.9	No
A1B0C1D1E1F1G0H1I1J0K0	265.6	11.87	395.96	No
A0B1C1D1E1F1G0H1I1J0K0	276.7	12.67	421.44	No
A1B1C1D1E1F1G0H1I1J0K0	286.3	12.92	428.5	No
A0B0C0D0E0F0G1H1I1J0K0	221.8	10	348.19	No
A1B0C0D0E0F0G1H1I1J0K0	231.4	10.25	355.25	No
A0B1C0D0E0F0G1H1I1J0K0	242.5	11.05	380.73	No
A1B1C0D0E0F0G1H1I1J0K0	252.1	11.3	387.79	No
A0B0C1D0E0F0G1H1I1J0K0	243.2	10.54	362.94	No
A1B0C1D0E0F0G1H1I1J0K0	252.8	10.79	370	No
A1B0C1D0E1F1G0H1I1J1K0	271.7	12.15	407.8	No
A0B1C1D0E1F1G0H1I1J1K0	282.8	12.95	433.28	No
A1B1C1D0E1F1G0H1I1J1K0	292.4	13.2	440.34	No
A0B0C0D1E1F1G0H1I1J1K0	246.9	11.64	392.91	Yes
A1B0C0D1E1F1G0H1I1J1K0	256.5	11.89	399.97	No
A0B1C0D1E1F1G0H1I1J1K0	267.6	12.69	425.45	Yes
A1B1C0D1E1F1G0H1I1J1K0	277.2	12.94	432.51	Yes
A0B0C1D1E1F1G0H1I1J1K0	268.3	12.18	407.66	No
A1B0C1D1E1F1G0H1I1J1K0	277.9	12.43	414.72	No
A0B1C1D1E1F1G0H1I1J1K0	289	13.23	440.2	No
A1B1C1D1E1F1G0H1I1J1K0	298.6	13.48	447.26	No
A0B0C0D0E0F0G1H1I1J1K0	234.1	10.56	366.95	No
A1B0C0D0E0F0G1H1I1J1K0	243.7	10.81	374.01	No
A0B1C0D0E0F0G1H1I1J1K0	254.8	11.61	399.49	No
A1B1C0D0E0F0G1H1I1J1K0	264.4	11.86	406.55	No
A0B0C1D0E0F0G1H1I1J1K0	255.5	11.1	381.7	No
A1B0C1D0E0F0G1H1I1J1K0	265.1	11.35	388.76	No
A0B1C1D0E0F0G1H1I1J1K0	276.2	12.15	414.24	No

2048 Plans 5/1/2008

Cost Effectiveness Analysis (92 CE Plans)



Cost Effective & Best Buy Plans



Perform CE/ICA: Wetlands Restoration - HEP

IWR Planning Suite Planning Study "Eliz Wet May 2008" - [CEICA Analysis 4 (CE/ICA)]

File Edit View Window Analyze Results Decision Making Generator Help

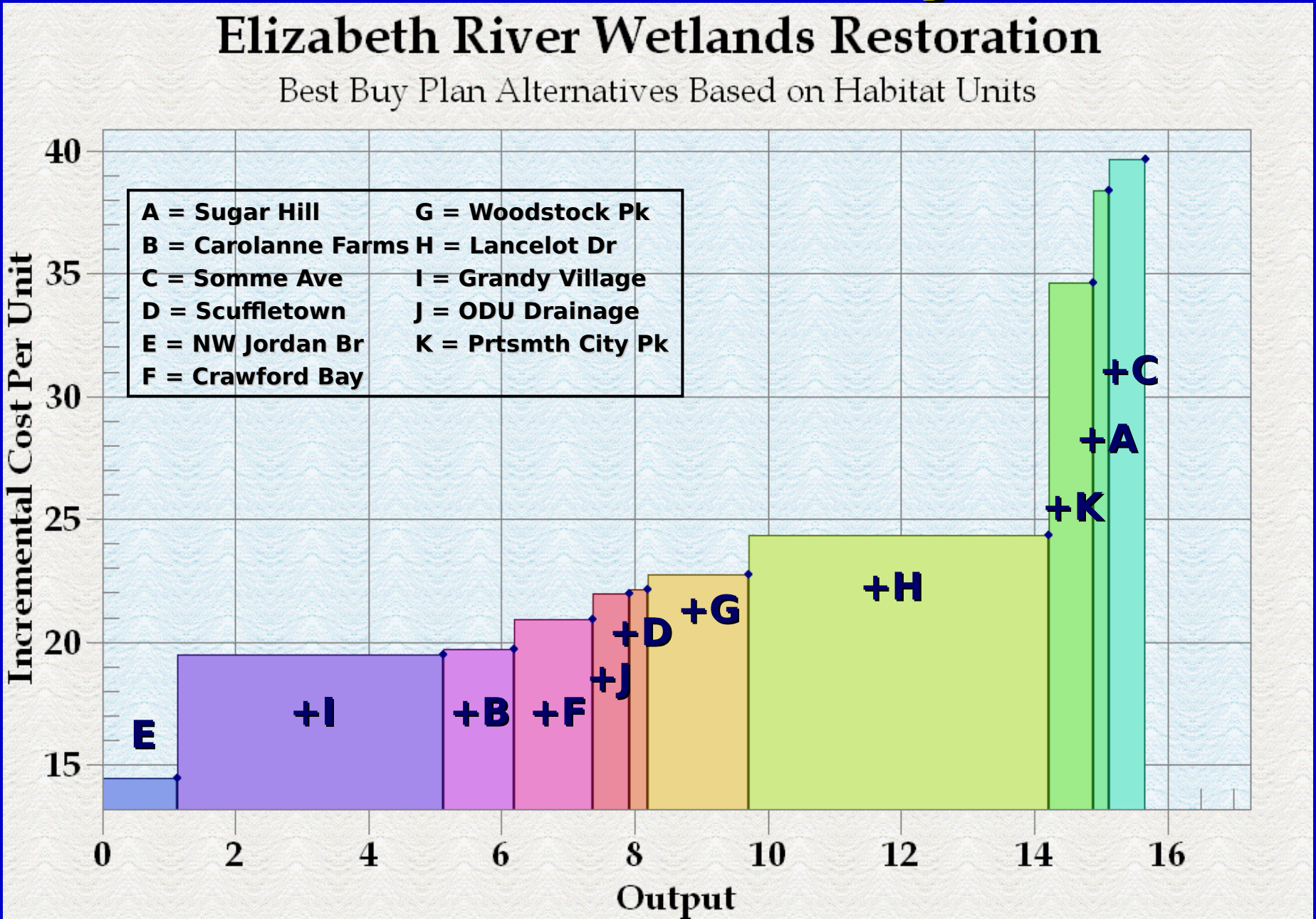
CEICA Analysis 4 (CE/ICA)

Name	Cost	Habitat	Functional Scor	Cost Effective
A0B1C0D1E1F1G1H1I1J1K0	302.2	14.21	473.69	Best Buy
No Action Plan	0	0	0	Best Buy
A0B0C0D0E1F0G0H0I0J0K0	16.5	1.14	31.61	Best Buy
A0B0C0D0E1F0G0H0I1J0K0	94.3	5.13	198.31	Best Buy
A0B1C0D0E1F1G0H0I1J1K0	152	7.92	285.28	Best Buy
A0B1C0D1E1F1G0H0I1J1K0	158.2	8.2	292.2	Best Buy
A0B1C0D0E1F0G0H0I1J0K0	115	6.18	230.85	Best Buy
A0B1C0D0E1F1G0H0I1J0K0	139.7	7.36	266.52	Best Buy
A0B1C0D1E1F1G1H0I1J1K0	192.8	9.72	340.44	Best Buy
A0B1C0D1E1F1G1H1I1J1K1	325.4	14.88	497.21	Best Buy
A1B1C0D1E1F1G1H1I1J1K1	335	15.13	504.27	Best Buy
A1B1C1D1E1F1G1H1I1J1K1	356.4	15.67	519.02	Best Buy

2048 Plans 5/1/2008

start Sent Items - Microsof... IWRPlanSuite_for_PC... Microsoft Excel - Eliza... IWR Planning Suite Pl... 12:44 PM

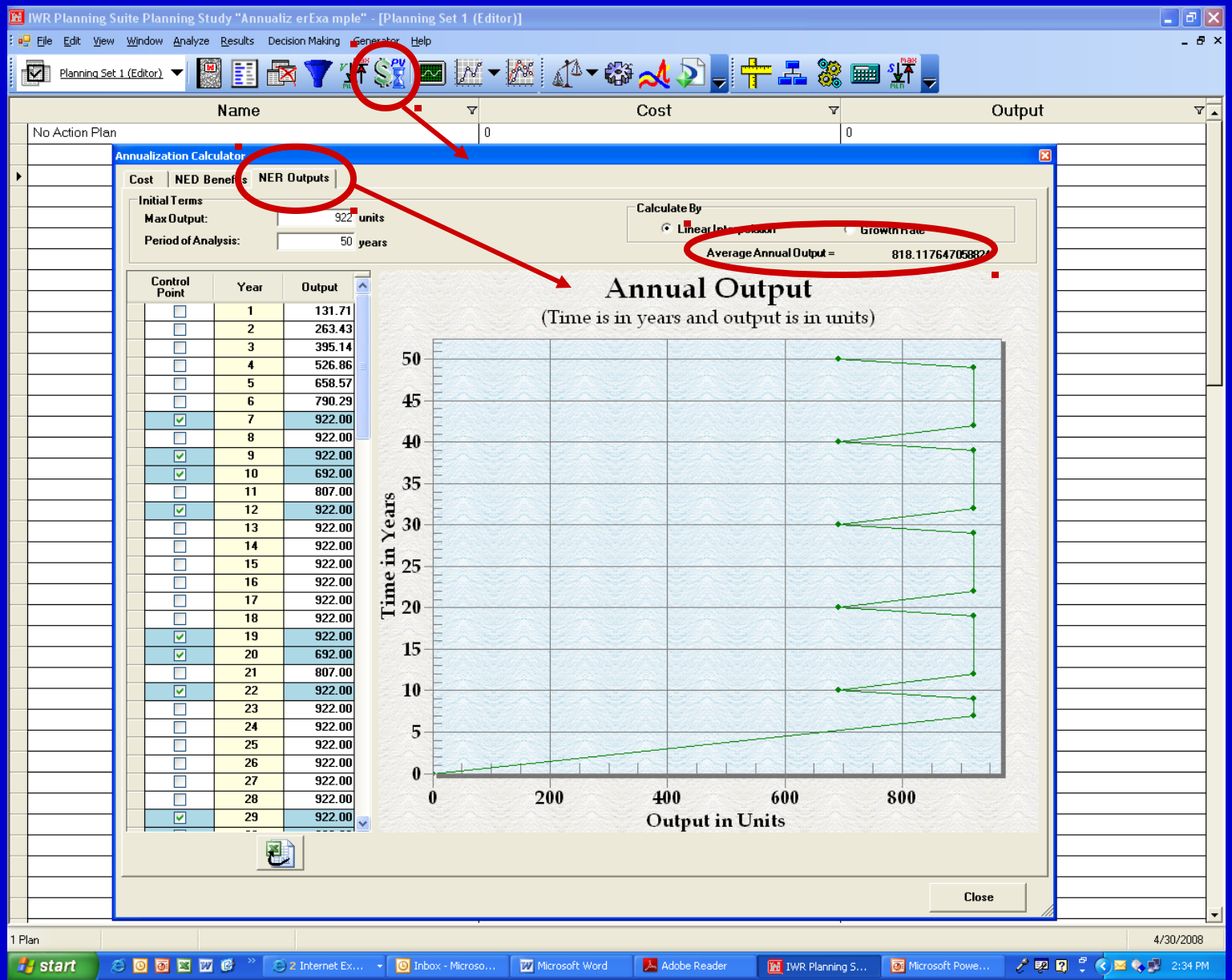
Incremental Cost Analysis (11 Best Buys)



ER 1105-2-100
(22 April 2000)

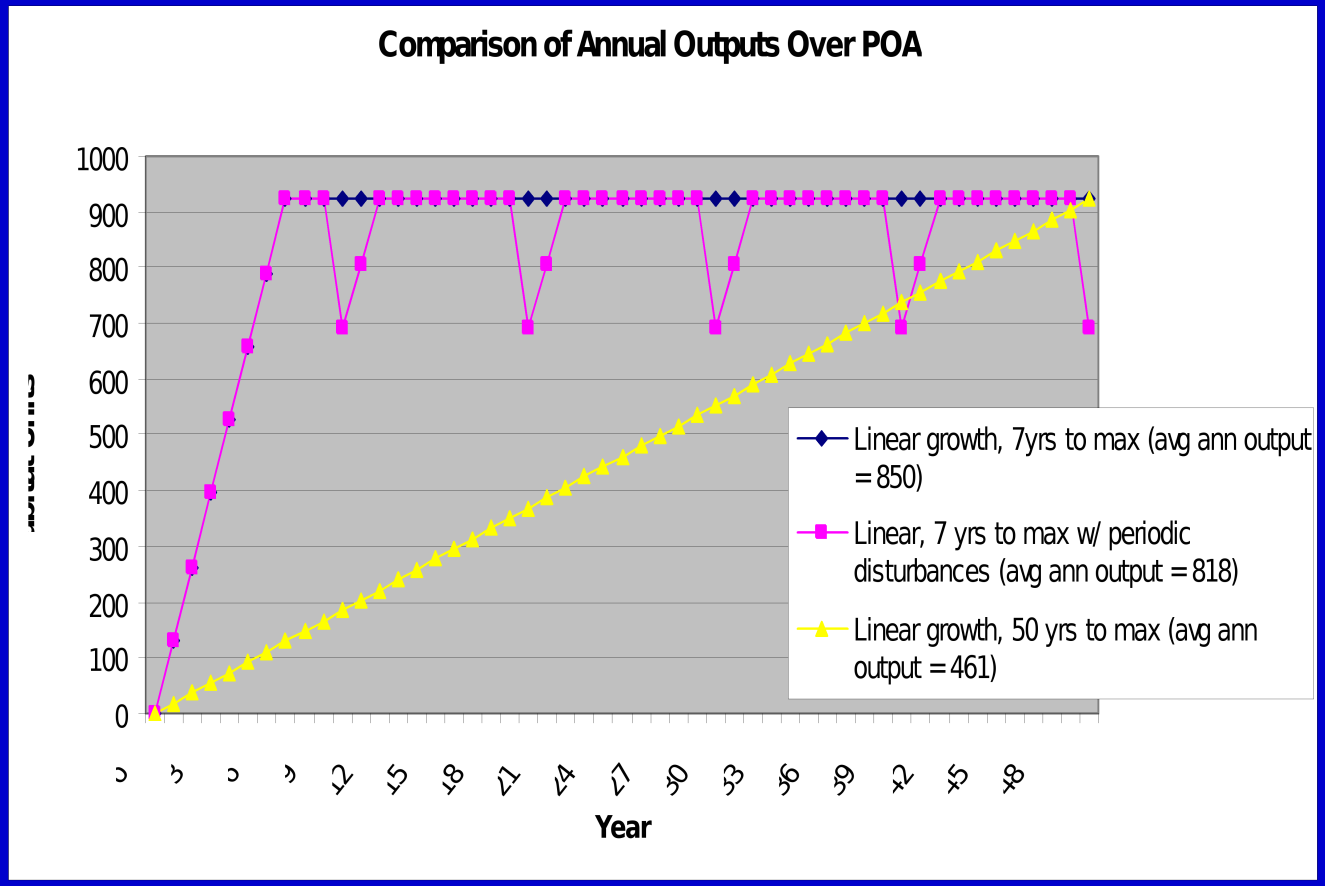
- "Selecting the NER plan requires careful consideration of the plan that meets **planning objectives and constraints** and reasonably maximizes environmental benefits while passing tests of **cost effectiveness and incremental cost analyses**, **significance** of outputs, **acceptability**, **completeness**, **efficiency**, and **effectiveness**." (Appendix E, E-41)

IWR Planning Suite Annualizer Module



IWR Planning Suite Annualizer Module

- Can address various assumptions regarding ecological response rates, disturbances, etc., that affect average annual outputs
- Can display for different alternatives how max output levels, & outputs over time, vary



IWR Planning Suite Annualizer Module

IWR Planning Suite Planning Study "Annualiz erExa mple" - [Planning Set 1 (Editor)]

File Edit View Window Analyze Results Decision Making Generator Help

Planning Set 1 (Editor)

Name	Cost	Output
No Action Plan	0	0

Annualization Calculator

Cost | NED Benefits | NER Outputs

Initial Terms

Discount Rate %: 4.875 %

Period of Analysis: 50 years

Capital Recovery Factor = 0.0537222821

Average Annual Cost = $712,801.61

Total Initial Cost

Construction		Real Estate		Monitoring		Other		
$10,000,000.00	+	$2,000,000.00	+	$100,000.00	+	$0.00	=	$12,100,000.00

Total Investment Cost

Total Initial Cost		PED		IDC		
$12,100,000.00	+	$400,000.00	+	$599,410.93 ...	=	$13,099,410.93

Cost Annualizer

Year	O&M Costs	PV Factor	Present Value
1	$0.00	0.953516090584029	$0.00
2	$0.00	0.909192935002649	$0.00
3	$0.00	0.866930092970345	$0.00
4	$0.00	0.826631793058732	$0.00
5	$50,000.00	0.788206715669828	$39,410.34
6	$0.00	0.751567786097571	$0.00
7	$0.00	0.716631977208649	$0.00
8	$0.00	0.683320121295494	$0.00
9	$0.00	0.651556730675083	$0.00
10	$50,000.00	0.621269826627016	$31,063.49
11	$0.00	0.59239077628321	$0.00
12	$0.00	0.564854137099604	$0.00
13	$0.00	0.538597508557429	$0.00
14	$0.00	0.513561390757978	$0.00
15	$50,000.00	0.489689049590444	$24,484.45
16	$0.00	0.466926388167288	$0.00
17	$0.00	0.445221824235793	$0.00
18	$0.00	0.424526173288003	$0.00
19	$0.00	0.404792537104175	$0.00
20	$50,000.00	0.385976197477163	$19,298.81

Net Totals

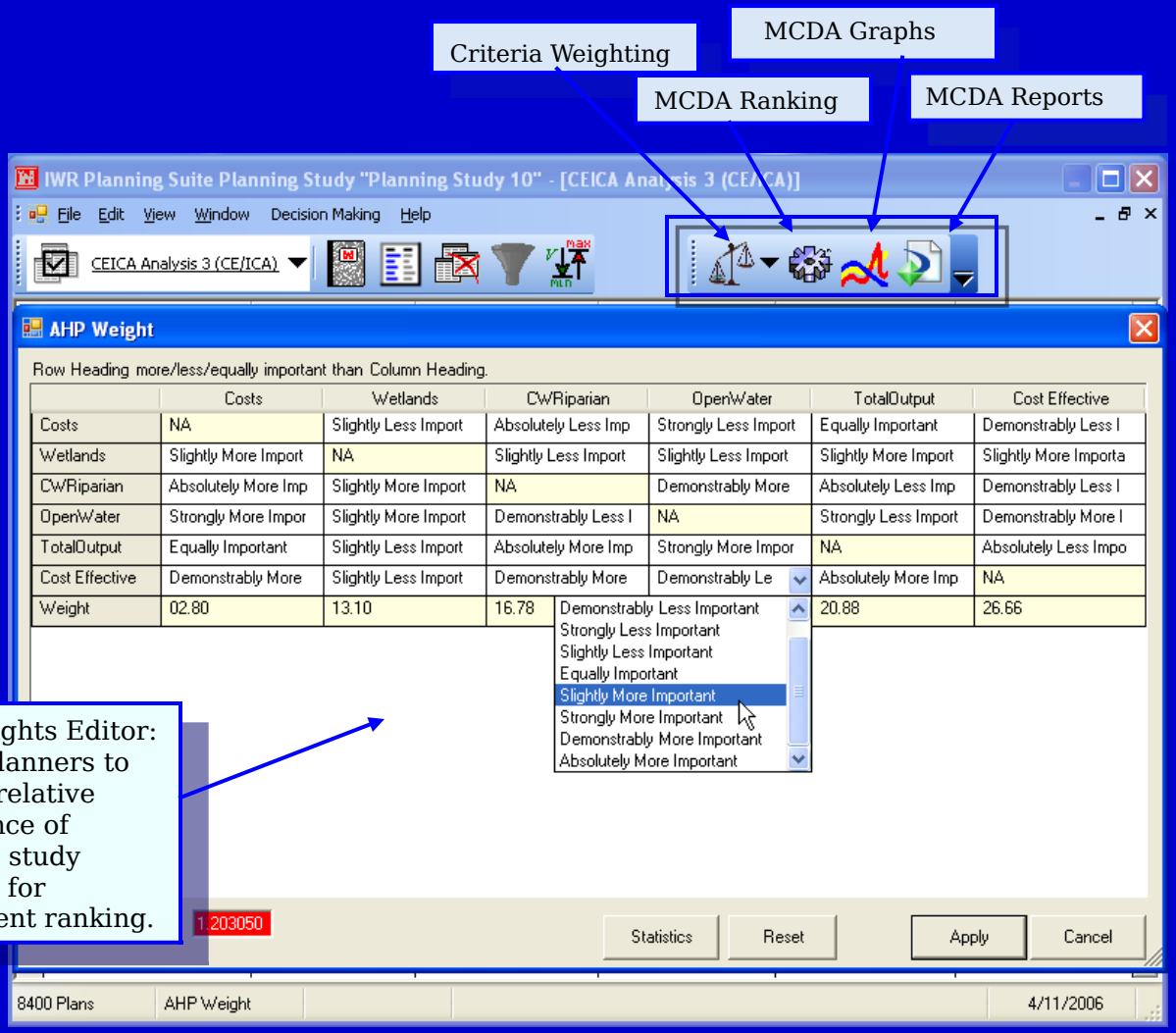
Construction and Cost	Present Value	Average Annual Cost
$13,599,410.93	$13,268,267.56	$712,801.61

Close

1 Plan 4/30/2008

start 2 Internet Ex... Inbox - Microso... Microsoft Word Adobe Reader IWR Planning S... Microsoft Power... 2:56 PM

IWR Planning Suite MCDA Module



AHP Weights Editor: Allows planners to edit the relative importance of planning study criterion for subsequent ranking.

IWR Planning Suite

Benefits of Multicriteria Decision Analysis Tools

- Provides 1 framework under which to conduct multi-objective, multi-criteria analyses
- Speedy construction and elucidation of the decision-making process
- Deeper insight into the factors affecting the decision
- Understanding of how sensitive the decision results are to judgments employed
- Illuminates trade-offs
- Collaborative process involved can be as useful as results themselves
  - Can lead to greater consensus and commitment from group members
- <u>Supports rather than replaces decision-making</u>

MCDA Basic Framework – 4 Part Process

1) Create decision matrix
2) Develop weights
3) Score/Rank alternatives
4) Analyze results

Create Decision Matrix

IWR Planning Suite Planning Study "Salt River Example" - [MCDM Planning Set 7]

File Edit View Window Analyze Results Decision Making Generator Help

MCDM Planning Set 7

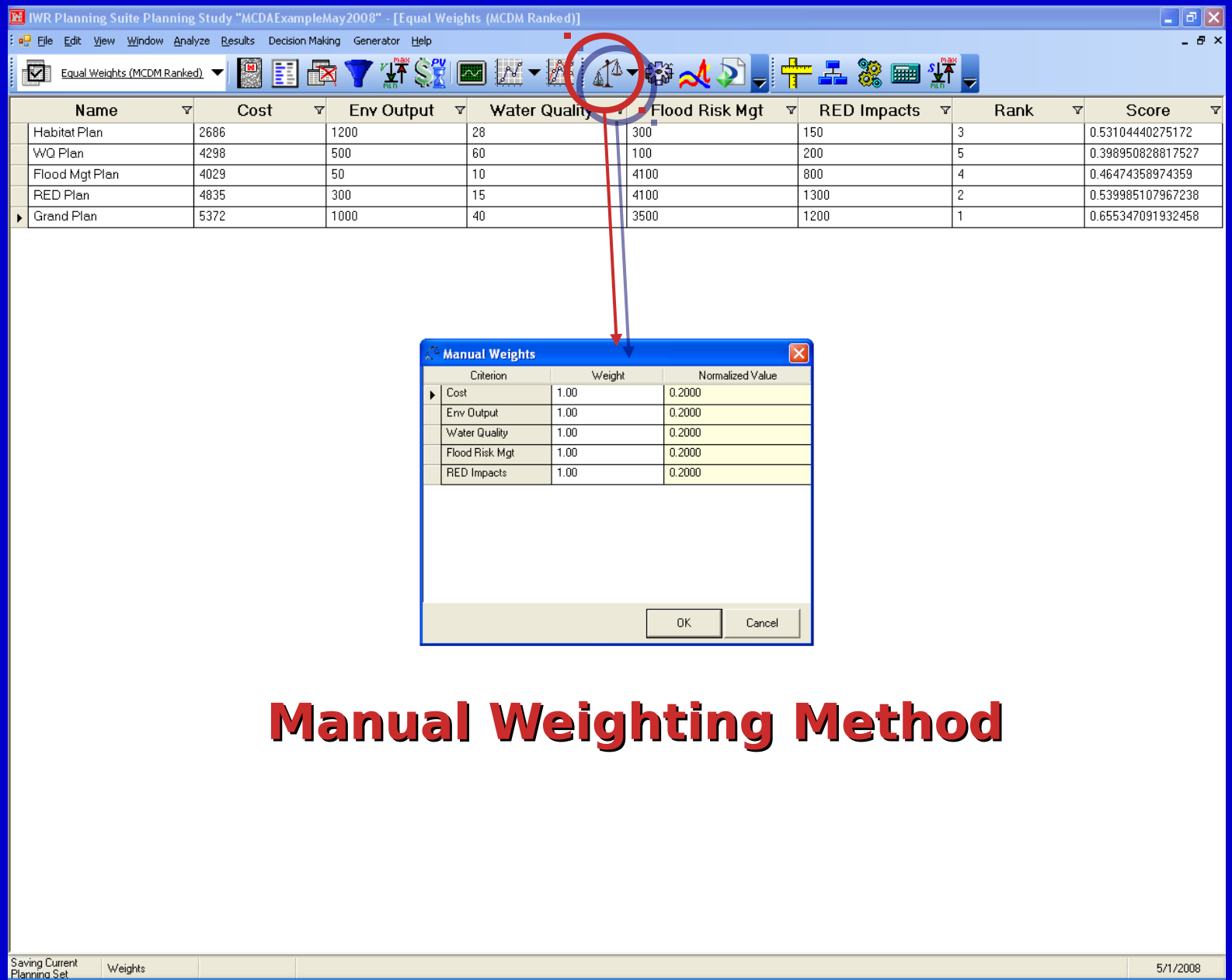
Name	Cost	Riparian	Open Water	Riverine Wetlan	Air Output	Phosphorus Redu	Acceptability	Cost Effective
No Action Plan	0	0	0	0	0	0	0	Best Buy
A1B0C0D0E0	100	59	10	111	180	3	2	Best Buy
A0B1C0D0E0	156	59	33	120	212	3.5	3	Yes
A0B0C1D0E0	201	59	33	120	212	3.5	5	No
A0B0C0D1E0	226	90	39	130	259	5	8	Yes
A0B0C0D0E1	309	99	60	180	339	9	2	Best Buy

- **Goal: select "best" alternative**
- **Identify the criteria important to alternative selection**
- **Judge/ weight the importance of criteria**
- **Evaluate each alternative**
- **Score/ rank each alternative**
- **Check reasonableness**
- **Finalize & document decision**

0 Plans 11/16/2006

start Inbox - Microsoft Out... Microsoft PowerPoint ... IWR Planning Suite Pl... 7:09 AM

Judge, Weight Criteria Importance



Name	Cost	Env Output	Water Quality	Flood Risk Mgt	RED Impacts	Rank	Score
Habitat Plan	2686	1200	28	300	150	3	0.53104440275172
WQ Plan	4298	500	60	100	200	5	0.398950828817527
Flood Mgt Plan	4029	50	10	4100	800	4	0.46474358974359
RED Plan	4835	300	15	4100	1300	2	0.539985107967238
Grand Plan	5372	1000	40	3500	1200	1	0.655347091932458

Criterion	Weight	Normalized Value
Cost	1.00	0.2000
Env Output	1.00	0.2000
Water Quality	1.00	0.2000
Flood Risk Mgt	1.00	0.2000
RED Impacts	1.00	0.2000

Manual Weighting Method

Judge/ Weight Criteria Importance

IWR Planning Suite Planning Study "MCDAExampleMay2008" - [AH

File Edit View Window Analyze Results Decision Making Generator Help

AHP Weights - Cost Strongly/Absolutely More Import (MCDM Ranked)

Name	Cost	Env Output	Water Quality	Flood Risk Mgt	RED Impacts	Rank	Score
Habitat Plan	2686	1200	28	300	150	1	0.78534023764853
WQ Plan	4298	500	60	100	200	3	0.395513472563129
Flood Mgt Plan	4029	50	10	4100	800	2	0.485086538461538
RED Plan	4835	300	15	4100	1300	4	0.357543149664929
Grand Plan	5372	1000	40	3500	1200	5	0.304288242651657

AHP Weight

Row Heading more/less/equally important than Column Heading.

	Cost	Env Output	Water Quality	Flood Risk Mgt	RED Impacts
Cost	NA	Strongly More Important	Absolutely More Importa	Strongly More Important	Absolutely More Importa
Env Output	Strongly Less Important	NA	Equally Important (1)	Equally Important (1)	Equally Important (1)
Water Quality	Absolutely Less Importa	Equally Important (1)	NA	Equally Important (1)	Equally Important (1)
Flood Risk Mgt	Strongly Less Important	Equally Important (1)	Equally Important (1)	NA	Equally Important (1)
RED Impacts	Absolutely Less Importa	Equally Important (1)	Equally Important (1)	Equally Important (1)	NA
Weight	62.92	09.82	08.72	09.82	08.72

Inconsistency Ratio: 0.012420

Help Statistics Reset Apply Cancel

Saving Current Planning Set | AHP Weight | 5/1/2008

Analytic Hierarchy Process (AHP) Method

Score/ Rank Alternatives

IWR Planning Suite Planning Study "MCDAExampleMay2008" - [Equal Weights (MCDM Ranked)]

File Edit View Window Analyze Results Decision Making Generator Help

Equal Weights (MCDM Ranked)

Name	Cost	Env Output	Water Quality	Flood Risk Mgt	RED Impacts	Rank	Score
Habitat Plan	2686	1200	28	300	150	3	0.53104440275172
WQ Plan	4298	500	60	100	200	5	0.398950828817527
Flood Mgt Plan	4029	50	10	4100	800	4	0.46474358974359
RED Plan	4835	300	15	4100	1300	2	0.539985107967238
Grand Plan	5372	1000	40	3500	1200	1	0.655347091932458

Rank Planning Set

Rank Method

- (•) Weighted Scoring
- ( ) Outranking
- ( ) Efficient Frontier
- ( ) Compromise Programming

Criterion	Weight	Min/Max
Cost	1.00	Minimize
Env Output	1.00	Maximize
Water Quality	1.00	Maximize
Flood Risk Mgt	1.00	Maximize
RED Impacts	1.00	Maximize

Normalization

- ( ) By Range
- (•) By Percent of Max
- ( ) By Percent of Total

[x] Exclude No Action Plan from Ranking

OK Cancel

Ranking Methods: Weighted Scoring, Promethee, Efficiency Frontier, Compromise Programming

Saving Current Planning Set | Ranking | 5/1/2008

Score/ Rank Alternatives

- **Weighted Scoring:**
  - Most “intuitive”
  - Scores between 0 & 1
  - Normalize by % of maximum, % of total, or % of range
- **Promethee:**
  - “Preference ranking organization method for enrichment evaluations”
  - Outranking (which alts outrank others)
  - User can specify preference functions (strict/absolute, threshold, step, linear over range, linear with threshold)
  - Negative scores possible
- **Efficiency Frontier**
  - Dominated/ non-dominated alternatives
  - Score of 0 or 1
- **Compromise Programming**
  - Measures “distance from ideal” on multiple criteria
  - “Ideal” alt identified for each criterion; Ideal alt constructed w/ best value for each criterion; values normalized; use distance function to find least distance to ideal
  - Lowest score (least distance from ideal) is superior

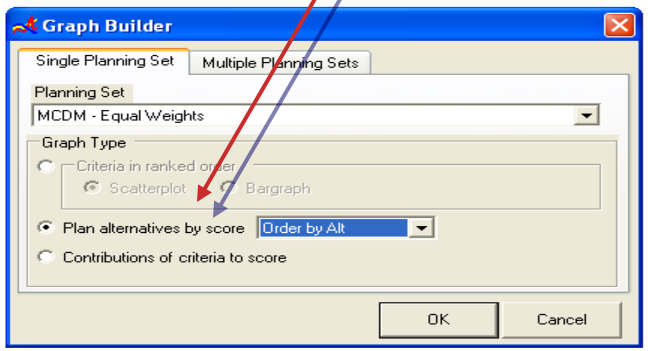
Display Graphical Results

IWR Planning Suite Planning Study "MCDAExampleMay2008" - [MCDM - Equal Weights (MCDM Ranked)]

File Edit View Window Analyze Results Decision Making Generator Help

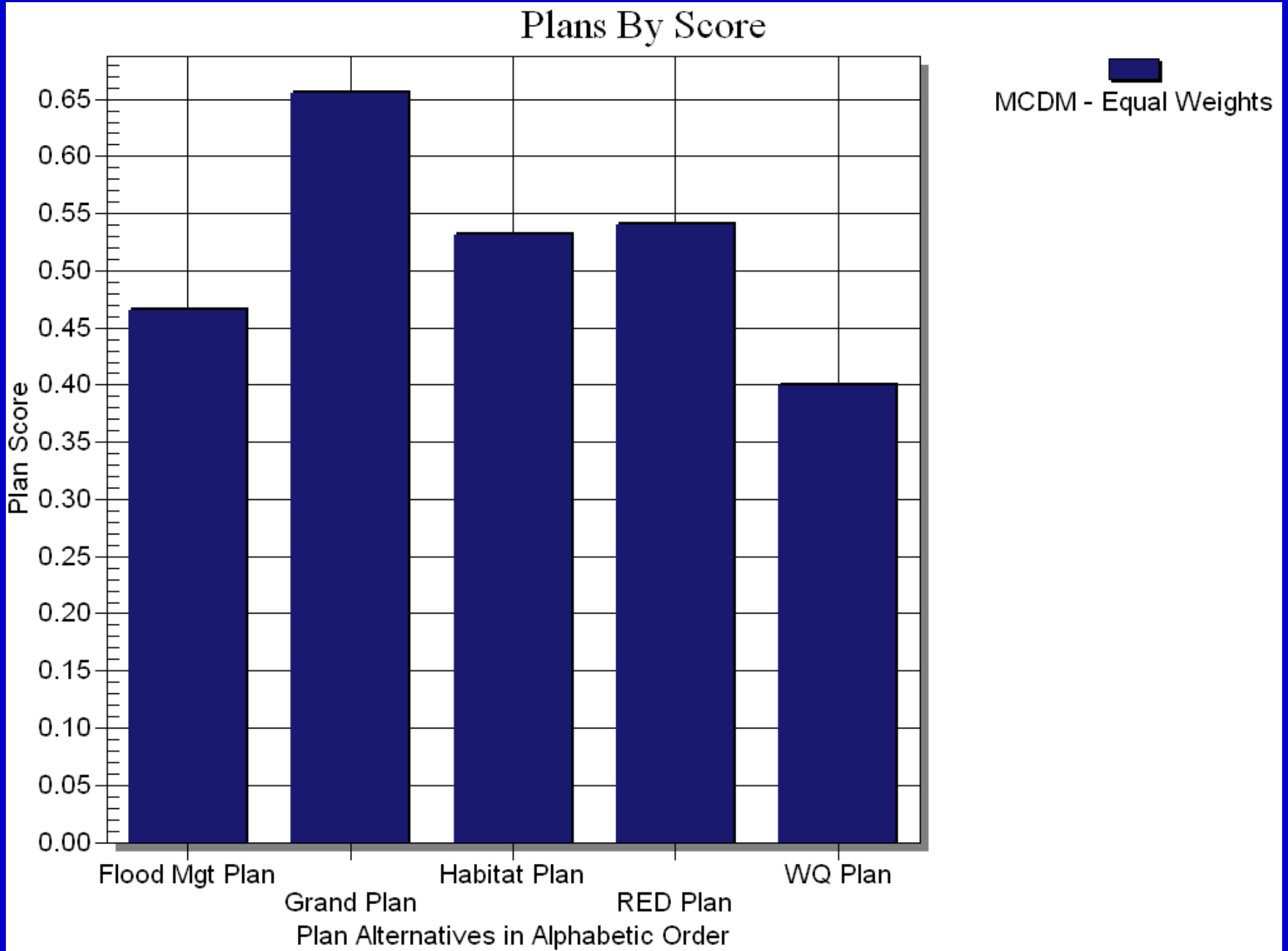
MCDM - Equal Weights (MCDM Ranked)

Name	Cost	Env Output	Water Quality	Flood Risk Mgt	RED Impacts	Rank	Score
Habitat Plan	2686	1200	28	300	150	3	0.53104440275172
WQ Plan	4298	500	60	100	200	5	0.398950828817527
Flood Mgt Plan	4029	50	10	4100	800	4	0.46474358974359
RED Plan	4835	300	15	4100	1300	2	0.539985107967238
Grand Plan	5372	1000	40	3500	1200	1	0.655347091932458

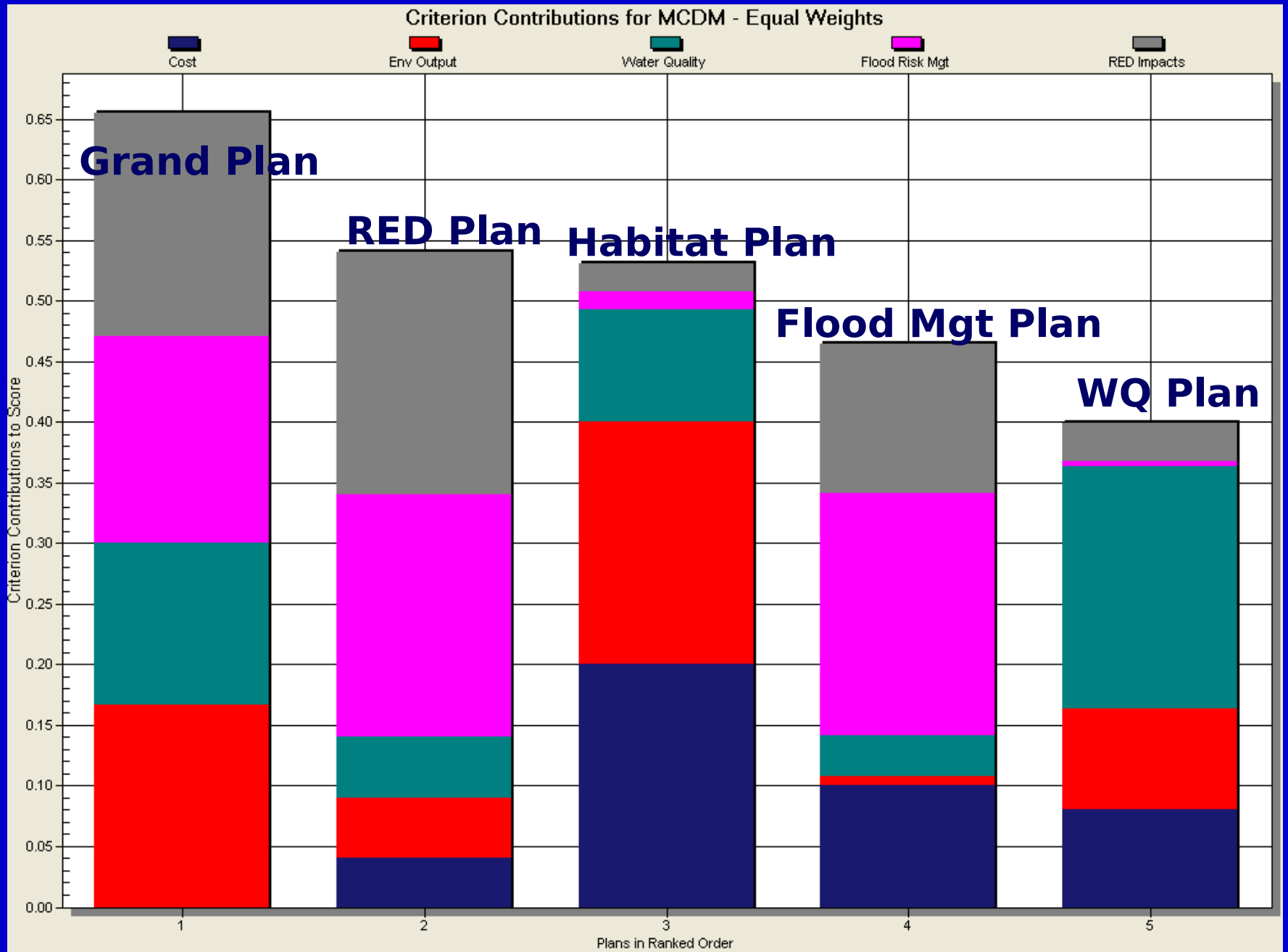


Saving Current Planning Set | Graphs | 5/1/2008

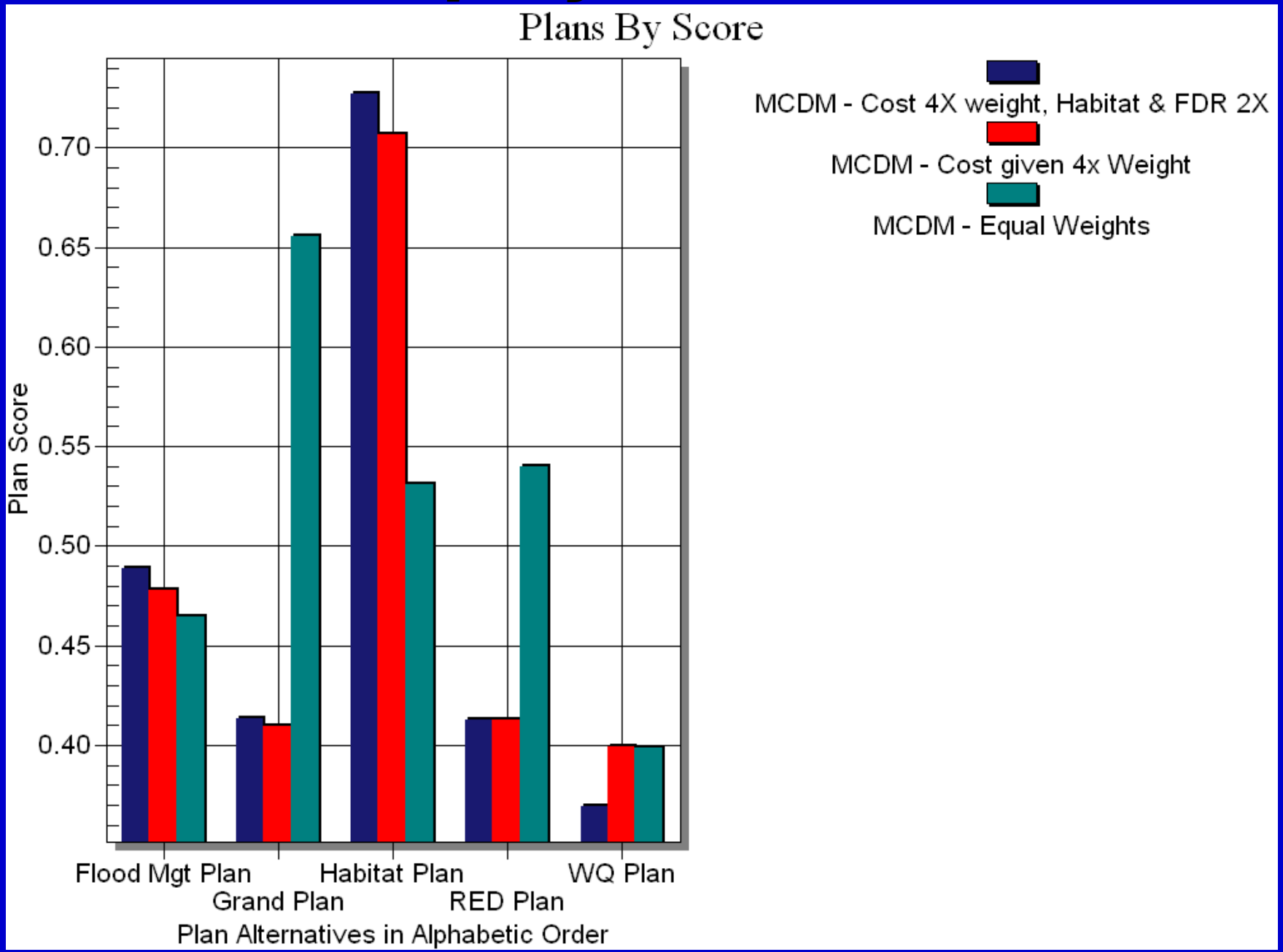
Display Results



Display Results



Display Results



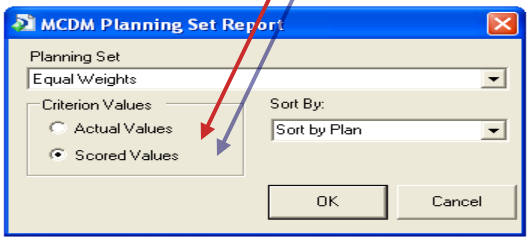
Display Report Results

IWR Planning Suite Planning Study "MCDAExampleMay2008" - [Equal Weights (MCDM Ranked)]

File Edit View Window Analyze Results Decision Making Generator Help

Equal Weights (MCDM Ranked)

Name	Cost	Env Output	Water Quality	Flood Risk Mgt	RED Impacts	Rank	Score
Habitat Plan	2686	1200	28	300	150	3	0.53104440275172
WQ Plan	4298	500	60	100	200	5	0.398950828817527
Flood Mgt Plan	4029	50	10	4100	800	4	0.46474358974359
RED Plan	4835	300	15	4100	1300	2	0.539985107967238
Grand Plan	5372	1000	40	3500	1200	1	0.655347091932458



Saving Current Planning Set | Reports | 5/1/2008

Display Results

Report Viewer

Main Report

MCDM Planning Set Report - Scored Criterion Values

Equal Weights (MCDM Ranked)

Ranking Method: Weighted Scoring
Normalization: By Percent of Max

Criteria	Weight	Optimization
Cost	1.00	Minimize
Env Output	1.00	Maximize
Water Quality	1.00	Maximize
Flood Risk Mgt	1.00	Maximize
RED Impacts	1.00	Maximize

Rank	Name	Score	Cost	Env Output	Water Quality	Flood Risk Mgt	RED Impacts
3	Habitat Plan	0.5310	0.2000	0.2000	0.0933	0.0146	0.0231
5	WQ Plan	0.3990	0.0800	0.0833	0.2000	0.0049	0.0308
4	Flood Mgt Plan	0.4647	0.1000	0.0083	0.0333	0.2000	0.1231
2	RED Plan	0.5400	0.0400	0.0500	0.0500	0.2000	0.2000
1	Grand Plan	0.6553	0.0000	0.1667	0.1333	0.1707	0.1846

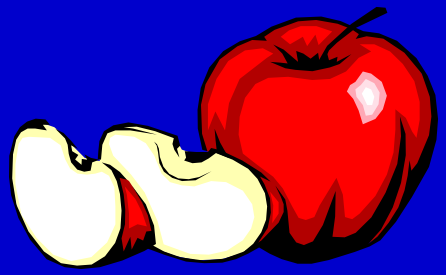
Current Page No.: 1 | Total Page No.: 1 | Zoom Factor: 150%

Applicability

- Restoration and mitigation
- All scopes of problems
- All types of resources
  - HU's, acres, river miles, IBI
- All scales of projects
- All phases of work
- Many agencies and interests

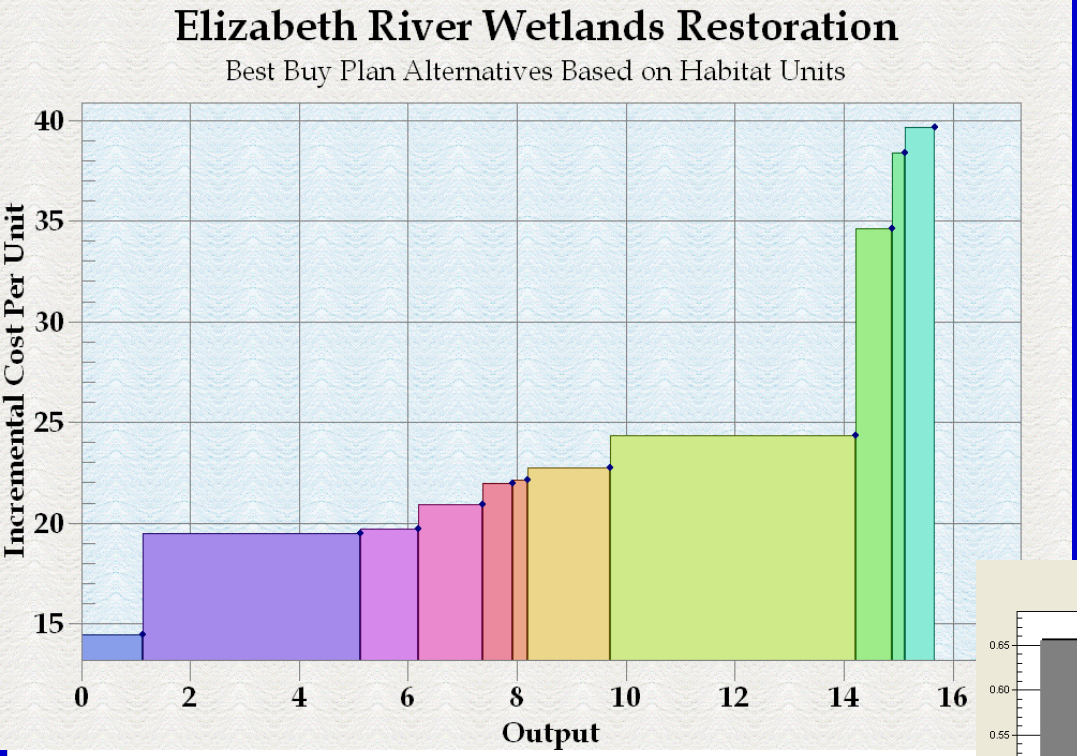
Challenges

- K.I.S.S. - don’t go too fast too soon
- Set-up - getting started
- Output quantification
- Commensuration
  - Multiple metrics

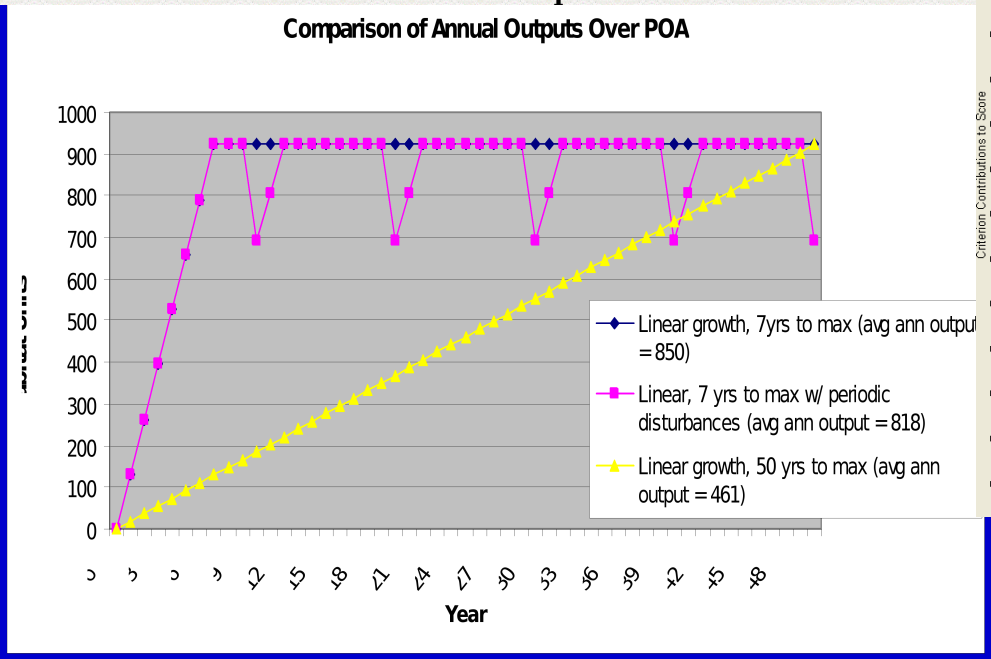


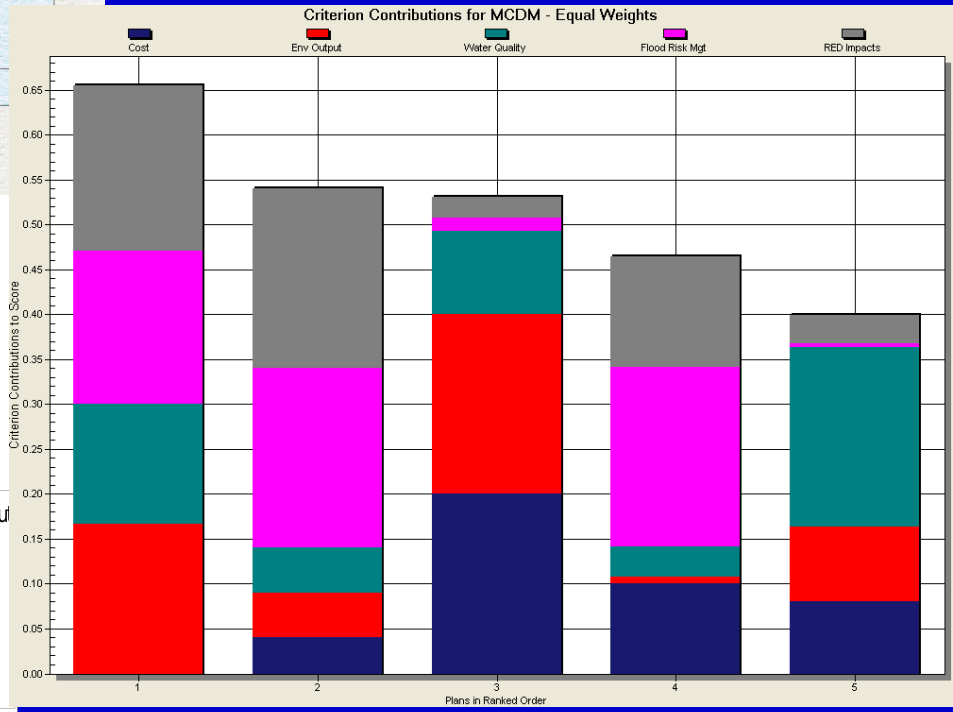
Benefits

- Flexibility
  - Handles various resources & approaches
  - From simple to complex
- Rational, equitable approach
- Saves time
- Saves costs
  - Greatest “bang for the buck”
- Allows you to focus on what’s important
- It’s easy
- More informed decisions!


Elizabeth River Wetlands Restoration
Best Buy Plan Alternatives Based on Habitat Units
Incremental Cost Per Unit
40
35
30
25
20
15
0
2
4
6
8
10
12
14
16
Output

Questions ?


Comparison of Annual Outputs Over POA
1000
900
800
700
600
500
400
300
200
100
0
Linear growth, 7yrs to max (avg ann output = 850)
Linear, 7 yrs to max w/ periodic disturbances (avg ann output = 818)
Linear growth, 50 yrs to max (avg ann output = 461)
Year


Criterion Contributions for MCDM - Equal Weights
Cost
Env Output
Water Quality
Flood Risk Mgt
RED Impacts
Criterion Contributions to Score
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1
2
3
4
5
Plans in Ranked Order